WHAT IS CLAIMED IS:

1. A particle production apparatus comprising:

a reaction chamber;

a reactant inlet defining a reactant path through the reaction chamber, the reactant inlet being connected to a reactant delivery system; and

optical elements defining a light path through the reaction chamber that intersects the reactant path, where the light path through the reaction chamber does not follow a single straight line path.

2. The particle production apparatus of claim 1 wherein the reactant inlet is generally rectangular, with the width of the reaction chamber being substantially greater than the width of an incident light beam directed along the light path.

3. The particle production apparatus of claim 1 wherein the reactant inlet is generally elliptical.

4. The particle production system of claim 1 wherein the optical elements comprise a reflector.

5. The particle production system of claim 1 wherein the optical elements comprise two reflectors generally facing each other.

6. The particle production system of claim 5 wherein the reflectors are flat mirrors.

7. The particle production system of claim 5 wherein at least one reflector is curved.

8. The particle production system of claim 1 wherein the reactant inlet moves such that reactants are directed to different portions of the reaction chamber.

9. A particle production apparatus comprising:

a reaction chamber;

a reactant inlet defining a reactant path through the reaction chamber, the reactant inlet being connected to a reactant delivery system;

a light source; and

optical elements directing a light beam from the light source through the reaction chamber that intersects the reactant path, the optical elements comprising a focusing element and a collimating element.

10. The particle production apparatus of claim 9 wherein the focusing element comprises a defocusing spherical lens.

11. The particle production apparatus of claim 9 wherein the collimating optics comprise telescope optics.

12. The particle production apparatus of claim 9 wherein the focusing element comprises a cylindrical lens.

13. The particle production apparatus of claim 9 wherein the light source is a laser.

14. The particle production apparatus of claim 9 wherein the light beam at any point along the reaction zone has a maximum thickness along the reactant flow path less than about a factor of ten larger than the minimum thickness value.

15. A method of producing a collection of nanoscale particles having a selected average particle diameter, the method comprising reacting a reactant stream within a reaction chamber with a light beam, where the average time of flight of the reactant stream through the light beam is selected by changing the

properties of the light beam to produce the selected average particle diameter.

16. The method of claim 15 wherein the light beam is shaped with collimating optics.

17. The method of claim 15 wherein the light beam is shaped with telescope optics.

18. The method of claim 17 wherein the telescopic optics are adjustable such that adjustment of the telescopic optics can be used to select the desired time of flight.

19. The method of claim 15 wherein the light beam at any point along the reaction zone has a maximum thickness along the reactant flow path less than about a factor of ten larger than the minimum thickness value.

20. A particle production system comprising:

a plurality of reactant inlets configured to direct a reactant stream toward one or more product outlets; and

a particle collection apparatus connected to the one or more product outlets to collect the product particles generated by the reactants from the plurality of reactant inlets.

21. The particle production system of claim 20 with a single reaction chamber.

22. The particle production system of claim 21 comprising a reactant delivery system that delivers different reactants to at least two of the plurality of reactant inlets having a flow separated by shielding gas.

23. The particle production system of claim 20 comprising a plurality of reaction chambers, each reaction chamber comprising a product outlet.

24. The particle production system of claim 23 comprising a manifold connected to the product outlets of the reaction chambers such that the product particles are mixed within the manifold.

25. The particle production system of claim 23 wherein at least two reaction chambers are aligned such that a single light beam passes through the two reaction chambers.

26. The particle production system of claim 23 wherein at least one of said reaction chambers comprises a reactant delivery system that delivers different reactants to at least two reactant inlets having a flow separated by shielding gas.

27. The particle production system of claim 20 comprising three reaction chambers.

28. A method of producing a mixture of particles, the method comprising:

supplying different reactant streams to two reactant inlets;

reacting the distinct reaction streams to produce two product particle streams, each with different product particle compositions; and

directing the two product particle streams to a single particle collector such that a mixture of product particles are collected.

29. The method of claim 28 wherein the two reactant inlets are located within a single reaction chamber.

30. The method of claim 28 wherein the two reactant inlets are located in different reaction chambers, the reaction chambers being connected to a single manifold leading to the collector.

31. A particle production apparatus comprising:

a reaction chamber;

a reactant inlet generating a reactant stream through the reaction chamber, the reactant inlet being connected to a reactant delivery system;

optical elements defining an optical path through the reaction chamber, where the optical path intersects the reactant stream at a reaction zone; and

a spectrometer connected to the reaction chamber by way of suitable optics to measure optical properties of the reactant/product stream.

32. The particle production apparatus of claim 31 wherein the spectrometer is oriented to measure emissions from the reaction zone.

33. The particle production apparatus of claim 31 wherein the spectrometer is oriented to measure emissions of the reactant/product stream at a position downstream from the reaction zone.

34. The particle production apparatus of claim 31 wherein the spectrometer is oriented to measure absorption by the reactant/product stream.

35. The particle production apparatus of claim 31 wherein the spectrometer measures light in the visible portion of the electromagnetic spectrum.

36. The particle production apparatus of claim 31 wherein the spectrometer measures light in the ultraviolet portion of the electromagnetic spectrum.

37. The particle production apparatus of claim 31 wherein the spectrometer measures light in the infrared portion of the electromagnetic spectrum.

38. The particle production apparatus of claim 31 further comprising a light source, wherein the intensity of the light source is adjusted based on fluctuations in the measurements of the spectrometer.

39. The particle production apparatus of claim 38 wherein the intensity of the light source is further adjusted based on fluctuations in pressure and in reactant flow rates.

40. A method of selecting reaction conditions, the method comprising selecting the reaction conditions to produce a selected measurement on a spectrometer in a particle production apparatus of claim 31, wherein the selected measurement is correlated with a reaction product property.

41. The method of claim 40 wherein the reaction conditions are selected from the group consisting of chamber pressure, reactant flow rate, reactant stream composition and light intensity.

42. A particle production apparatus comprising:

a reaction chamber having a reactant inlet connected to a reactant delivery system and a product outlet, the reactant chamber having a plurality of shielding gas outlets connected to an inert gas delivery system such that inert gas is delivered along walls of the reaction chamber as a thin film; and

a particle collection apparatus connected to the product outlet.

43. The particle collection apparatus of claim 42 wherein inert gas flows directly into the plurality of outlets along a channel to direct the flow of inert gas as a thin film along the walls of the reaction chamber.

44. The particle collection apparatus of claim 42 wherein the plurality of shielding gas outlets comprise pores through porous metal such that inert gas flows into the reaction chamber through the pores.

45. A particle production system comprising:

a reaction chamber having a reactant inlet connected to a reactant delivery apparatus oriented to produce a reactant stream within the reactant chamber;

an optical element positioned to direct a light beam along a light path through the reaction chamber intersecting the reactant stream; and

a tapered tube extending from the reaction chamber along the light path, the tube supporting the optical element, and the tube having a smaller cross sectional area at the connection to the reaction chamber relative to the cross sectional area of the tube at the optical element.

46. A particle production system comprising:

a reaction chamber having a reactant inlet connected to a reactant delivery apparatus oriented to produce a reactant stream within the reactant chamber; and

optical elements positioned to direct two approximately parallel light beams, where the reactant stream is intersected by at least one light beam.

47. The particle production system of claim 46 wherein the reaction chamber comprises a second reactant inlet such that the first inlet generates a reactant stream that intersects one of the light beams while the

second inlet generates a reactant stream that intersects the other light beam.

48. The particle production system of claim 46 wherein the optical elements comprise a beam splitter.

49. The particle collection system of claim 46 wherein the optical elements comprise two reflectors.

50. The particle collection system of claim 46 wherein the reaction chamber comprises a second reactant inlet such that the first reactant inlet and the second reactant inlet generate reactant streams that are intersected by both light beams.

51. A particle production system comprising:

a light source;

optical elements to split the light beam from the light source into two beams; and

at least two reaction chambers, one of the light beams being directed to one reaction chamber and the other light beam being directed to the other reaction chamber.

add C6

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